

EFFECT OF CONTINUOUS REMOVAL OF FIELD-RATS ON THE MOVEMENTS AND SEX RATIO OF FIELD-MICE^{1,2}

G. S. MANN AND O. S. BINDRA³
(With a text-figure)

INTRODUCTION

There are many reports that the control measures against rats resulted in the increase in the population of *Mus* spp. (Barnett *et al.* 1951; Bentley 1967). Similarly, Hood (1968) reported that *Rattus norvegicus* was as numerous as *R. exulans* in fields not subjected to routine baiting, but the latter was predominant in areas with a history of baiting, and this suggested a change in species composition as a result of the baiting programme. To verify this, the influence of controlling rats on various aspects of *Mus* spp. ecobiology namely; (1) proportion of nomadic and settled individuals, (2) the duration of stay in the experimental area, (3) the migratory behaviour, and (4) the changes in sex-ratio etc. were determined to ascertain the cause for changes in the behaviour of *Mus* spp. if any.

MATERIAL AND METHODS

Studies on the movements were made by using the "capture, mark, release and recapture", method described by Davis (1964). The wonder traps fabricated at the Deccan Rat-Trap Factory, Jalgaon, Maharashtra were used for trapping. The bait used was a mixture of

husked rice, pearl-millet and wheat. It was placed in the main chamber of the trap on a piece of paper. In winter, dry grass was also put in the traps to provide some protection against cold. The schedule of 10-day observations (two-weeks study of 5 days each) was adopted in all the experiments. The observations on the sex and trap-site of individuals were made during the first fortnight of each month in the undisturbed ecosystem and in the second fortnight of each month in the disturbed ecosystem (by the regular control of rats). The specific details in respect of different experiments were as follows.

1. *Measurements of field-mice in wheat and groundnut fields:*

A 6-hectare field, under a wheat-groundnut rotation, was selected. In this field, the traps were laid out at intervals of 15 metres in a grid, having 18 × 3 rows. Thus a grid of 270 × 45 metres, consisting of 54 traps was laid in a homogeneous vegetation, with a belt of more than 30 metres of similar vegetation all around. The movement studies were made throughout 1970.

2. *Movements of field-mice after the regular control of field-rats:*

The control of rats was accomplished during January 1971 to November 1972 during the first 15 days of each month. Killing of new entrants was done, by resorting to burrow fumigation, using aluminium phosphide (Celphos tablets) and by trapping. In the centre of this block, a 2-hectare area was selected

¹ Accepted May 1977.

² Based on Ph.D. thesis of the senior author, presently Assistant Entomologist at the University.

³ Head, Department of Entomology, Punjab Agricultural University, Ludhiana.

to make counts of the field-mice, namely *Mus musculus bactrianus* Blyth and *Mus booduga* (Gray). The lay out and the field was the same as in the experiment on 'Movements of field-mice in wheat and groundnut fields'.

RESULTS AND DISCUSSION

A. Movements

1. Number of settled and nomadic field-mice:

The number of nomadic and settled mice of both the species did not differ significantly in all the wheat crops, i.e. 1970, 1970-71 and 1971-72 and of *M. m. bactrianus* in groundnut crop of 1970. The nomadic individuals of both the species were more ($p=0.10$) than settled ones in the ground crops of 1971 and 1972 and of *M. booduga* in 1970 (Tables 1 and 2).

crop of 1969-70 was still higher ($p = 0.10$). In the groundnut crop, the number of settled individuals was higher ($p = 0.10$) in 1971 than in 1970. In the groundnut crop of 1972, there was a significant ($p = 0.05$) decline in the number of settled individuals from that in the groundnut crop of 1971, and there was no difference in the population of settled individuals in the groundnut crops of 1972 and 1970.

The number of settled individuals of *M. m. bactrianus* did not differ in the three crops of wheat. However, in the groundnut crop of 1972, there was a significant ($p=0.10$) decline in the number of settled individuals of this species from that in the groundnut crop of 1970 (Table 2).

In the wheat crop of 1970, there was no

TABLE 1

NUMBER OF SETTLED AND NOMADIC FIELD-MICE IN A 2-HA GRID OF WHEAT AND GROUNDNUT FIELDS AT LUDHIANA DURING 1970

Period	Crop	Number of settled and nomadic field-mice in			
		<i>M. booduga</i>		<i>M. m. bactrianus</i>	
		Nomadic	Settled*	Nomadic	Settled
February	Wheat	1	0	7	5
March	-do-	5	7	9	20
April	-do-	0	5	6	4
May	-do-	—	—	1	0
July	Groundnut	—	—	—	—
August	-do-	7	3	3	2
September	-do-	5	0	3	5
October	-do-	6	0	13	10
November	-do-	9	4	19	6

* The rats/mice trapped more than once during a trapping-period of 10-days were considered to be settled (Newsome 1970).

In June and December, observations were not recorded as the land was under preparation.

The number of settled individuals of *M. booduga* was significantly ($p = 0.20$) higher in the wheat crop of 1971-72 than that in the wheat crop of 1970-71, and the increase in the wheat crop of 1971-72 over that in the wheat

real difference between the number of settled individuals of the two species, but in the groundnut season of 1970, the number of settled individuals of *M. m. bactrianus* were significantly ($p=0.20$) more than those of *M.*

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booduga (Table 1). In the wheat crop of 1970-71, there was no difference between the number of settled individuals of the two species, but in groundnut crop, the number of settled individuals of *M. booduga* was significantly ($p=0.05$) higher than that of *M. m. bactrianus*. In the wheat crop of 1971-72, the number of settled individuals of *M. booduga* was significantly ($p=0.05$) higher than that of *M. m. bactrianus*. In the next crop (groundnut) there was no difference between the number of settled individuals of the two species.

Thus the ecosystem disturbed through regular control measures against rats was more suitable for *M. booduga* than for *M. m. bac-*

trianus. However, there was a significant decline in the number of settled individuals of *M. booduga* during the groundnut season of 1972. This may be due to some physiological changes (Chity 1962) in the overcrowded population of this mouse in the previous crop, namely wheat of 1971-72 (Mann 1973) and this may be responsible for the low number of settled individuals during the groundnut season of 1972. In the groundnut crop of 1972, the number of settled individuals of the two species was almost equal. This may be due to increased immigration of *M. m. bactrianus* in the area vacated by the crash in the population of *M. booduga*.

TABLE 2

NUMBER OF SETTLED AND NOMADIC FIELD-MICE IN A 2-HA GRID OF WHEAT AND GROUNDNUT FIELDS AT LUDHIANA, WHERE THE FIELD-RATS WERE CONTINUOUSLY ELIMINATED

Period	Crop	Species			
		<i>M. booduga</i>		<i>M. m. bactrianus</i>	
		Nomadic	Settled	Nomadic	Settled
January 1971	Wheat	2	—	1	—
February 1971	-do-	7	3	5	10
March 1971	-do-	8	10	5	5
April 1971	-do-	6	1	6	16
May 1971	-do-	—	—	2	1
July 1971	Groundnut	2	—	1	—
August 1971	-do-	15	10	14	1
September 1971	-do-	28	23	11	10
October 1971	-do-	23	15	22	6
November 1971	-do-	11	11	7	1
January 1972	Wheat	15	12	—	1
February 1972	-do-	6	13	—	—
March 1972	-do-	9	10	3	1
July 1972	Groundnut	—	—	—	—
August 1972	-do-	6	2	5	—
September 1972	-do-	2	—	7	2
October 1972	-do-	4	1	6	2
November 1972	-do-	1	1	4	4

In June 1971, December 1971 and April to June 1972, observations were not recorded as the land was under preparation.

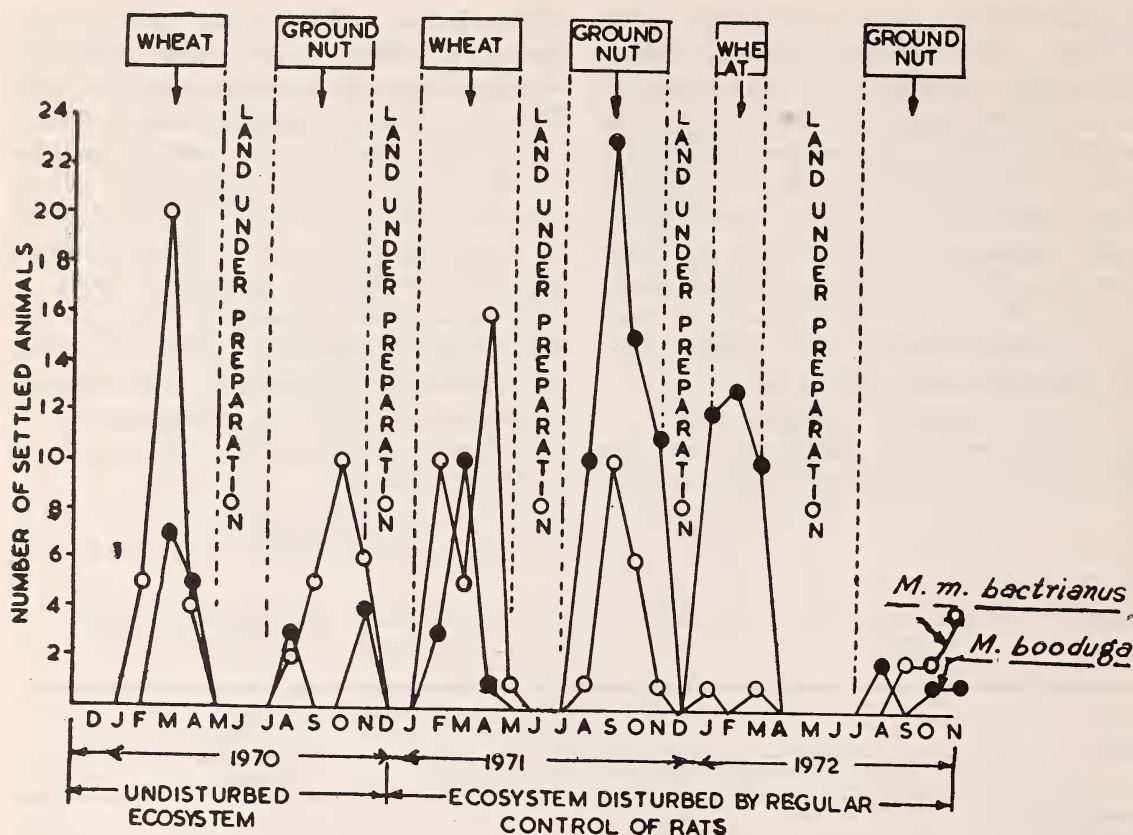


Fig. 1. Number of settled field-mice in wheat and groundnut fields at Ludhiana during 1970-72.

(2) *Duration of settled life:*

The duration for which field-mice remained settled in a 2-ha grid was as follows:

THE DURATION OF SETTLED LIFE IN DAYS

Species	Sex	Before the elimination of field-rats			Field-rats continuously eliminated		
		Number of animals observed	Mean \pm S. D.	Range	Number of animals observed	Mean \pm S. D.	Range
<i>M. m. bactrianus</i>	Male	35	7.9 \pm 7.7	2-29	36	11.4 \pm 13.9	2-53
	Female	22	8.6 \pm 9.5	2-34	12	11.2 \pm 10.7	2-33
	Average/total	57	8.2 \pm 8.4	2-34	48	11.4 \pm 12.9	2-53
<i>M. booduga</i>	Male	8	11.5 \pm 10.2	2-27	36	13.6 \pm 15.3	2-59
	Female	10	17.1 \pm 16.0	2-48	41	15.2 \pm 14.1	2-55
	Average/total	18	14.6 \pm 13.7	2-48	77	14.5 \pm 14.4	2-59

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A comparison of the above data suggests that the period of stay of both the species remained the same in the disturbed ecosystem as in the undisturbed ecosystem.

(3) Migration:

The migration was studied by determining the interval after which the field-mice re-entered the experimental area and the results are summarized below:

males outnumbered the females in both wheat and groundnut during 1971 and 1972. In the wheat crop of 1971-72, there were no females in the experimental area, confirming no reproductive potential in the population of this mouse. In the next crop (groundnut) there was a slight build-up of reproductive potential as indicated by the sex ratio. The males were more numerous than the females (Table 4).

(2) *Mus booduga* (Gray). In the case of

THE INTERVAL OF RE-ENTRY (DAYS)

Species	Sex	Before the elimination of field-rats			Field-rats continuously eliminated		
		Number of animals observed	Mean	Range	Number of animals observed	Mean	Range
<i>M. m. bactrianus</i>	Male	11	49.0	24-150	3	96.0	61-136
	Female	11	77.0	27-121	3	29.0	25-36
	Average/total	22	63.0	24-150	6	63.0	25-136
<i>M. booduga</i>	Male	4	116.0	31-289	8	99.0	51-130
	Female	2	73.0	34-112	8	138.0	54-279
	Average/total	6	102.0	31-289	16	119.0	51-279

The long interval after which re-entry took place suggests that both the species of field-mice move at random, and it is only by chance that the nomadic animals re-enter a given area. A comparison of the above data suggests that the migratory behaviour of both the species remains unchanged by the change in the habitat owing to the adoption of control measures against field-rats.

(B) Sex ratio

1. *Mus musculus bactrianus* Blyth. In the undisturbed ecosystem, the males were slightly more numerous than the females in the wheat crop, whereas the two sexes were equal in number in the groundnut crop (Table 3). In the ecosystem disturbed owing to the adoption of regular control measures against rats, the

this mouse, the number of females remained approximately equal to or slightly in excess of the number of males both in 1970 (i.e. before the use of control measures against field-rats) and in 1971-72 (i.e. after the elimination of field-rats) (Tables 3 and 4).

From the above account of the sex ratio, it appears that the habitat changed owing to the regular control of field-rats was less suited to *M. m. bactrianus* up to the wheat season of 1971-72 than to *M. booduga*. This may be due to the interspecific relationship of the two species of *Mus* in the absence of field-rats. In the groundnut crop of 1972, the crash of *M. booduga* population (Mann 1973) led to the reinvasion of the area by *M. m. bactrianus*. This mouse then started building up its numbers, as shown by an increase in the number

TABLE 3
SEX RATIO OF FIELD-MICE AT LUDHIANA DURING 1970

Period	Crop	Number of females per male	
		<i>M. booduga</i>	<i>M. m. bactrianus</i>
February	Wheat	—	0.33(9+3)
March	-do-	1.00(6+6)	0.76(17+13)
April	-do-	1.50(2+3)	1.50(4+6)
May	-do-	—	—(1+0)
Total/Average	-do-	1.13(8+9)	0.71(31+22)
July	Groundnut	—	—
August	-do-	2.33(3+7)	1.50(2+3)
September	-do-	0.25(4+1)	0.14(7+1)
October	-do-	2.00(2+4)	0.50(12+6)
November	-do-	3.33(3+10)	3.80(5+19)
Total/Average	-do-	1.88(12+22)	1.11(26+29)
Grand total/Average		1.50(20+31)	0.89(57+51)

Figures in the parentheses are number (male + female) of animals observed.

In June and December, observations were not recorded as the land was under preparation.

of females over males during this period as compared with the number in the wheat crop of 1970-71, the groundnut crop of 1971 and the wheat crop of 1971-72. This change in sex ratio of *M. m. bactrianus* may be due to less of interspecific competition between the two species of *Mus* owing to the crash in the population of *M. booduga* (Mann 1973).

SUMMARY

(1) These studies were made from February 1970 to November 1972 and the regular control of field-rats was done from January 1971 to November 1972.

(2) The changed ecosystem owing to the absence of the fields-rats was initially less suitable to *Mus musculus bactrianus* Blyth as evidenced by decrease in number of settled ani-

mals and also less suitable sex ratio as compared to undisturbed ecosystem, while this was reverse in *M. booduga* (Gray) and this process was continued till the wheat season of 1971-72 was over and in the next groundnut season, i.e. of 1972, there was a sudden decline in the number of settled animals of *M. booduga* and some recovery was present in *M. m. bactrianus*. This sudden decline in *M. booduga* was considered due to its high population during wheat season of 1971-72.

(3) The other characteristics of the populations, i.e. proportion of nomadic and settled individuals, period of stay and the migratory behaviour of both the species remained the same in both the habitats i.e. undisturbed ecosystem and in ecosystem disturbed by regular control of rats.

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TABLE 4

SEX RATIO OF FIELD-MICE IN A 2-HA GRID, WHERE THE FIELD RATS WERE CONTINUOUSLY ELIMINATED

Period	Crops	Number of females per male	
		<i>M. booduga</i>	<i>M. m. bactrianus</i>
January 1971	Wheat	—(0+1)	—(0+1)
February 1971	-do-	0.43(7+3)	2.00(3+6)
March 1971	-do-	0.22(9+2)	1.83(6+11)
April 1971	-do-	0.58(14+8)	0.75(4+3)
May 1971	-do-	—(3+0)	—(—)
Total/Average	-do-	0.42(33+14)	1.62(13+21)
July 1971	Groundnut	—(1+0)	—(0+2)
August 1971	-do-	0.15(13+2)	0.33(18+6)
September 1971	-do-	0.62(13+8)	0.78(27+21)
October 1971	-do-	0.83(12+10)	1.77(13+23)
November 1971	-do-	0.60(5+3)	1.63(8+13)
Total/Average	-do-	0.52(44+23)	0.98(66+65)
January 1972	Wheat	—(1+0)	0.80(15+12)
February 1972	-do-	—(—)	0.82(11+9)
March 1972	-do-	—(2+0)	2.33(6+14)
Total/Average	-do-	—(3+0)	1.09(32+35)
July 1972	Groundnut	—(—)	—(—)
August 1972	-do-	0.25(4+1)	1.75(4+7)
September 1972	-do-	0.57(7+4)	—(2+0)
October 1972	-do-	0.83(6+5)	1.50(2+3)
November 1972	-do-	0.67(6+4)	1.00(1+1)
Total/Average	-do-	0.61(23+14)	1.22(9+11)

Figures in the parentheses are number (Male + Female) of animals observed.
In June 1971, December 1971 and April to June 1972, observations were not recorded as the land was under preparation.

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